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Management of postoperative complications may favour the centralization of distal pancreatectomies. Nationwide data on pancreatic distal resections in Finland 2012–2014

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ABSTRACT

Background: Centralization of pancreatic surgery has proceeded in the last few years in many countries. However, information on the effect of hospital volume specifically on distal pancreatic resections (DP) is lacking.
Aim: To investigate the effect of hospital volume on postoperative complications in DP patients in Finland.
Methods: All DP performed in Finland during the period 2012–2014 were analyzed, information having been retrieved from the appropriate national registers. Hospital volumes, postoperative pancreatic fistulae (POPF) and overall complications were graded. High volume centre (HVC) was defined as performing > 10 DPs, median volume centre (MVC) 4–9 DPs and low volume centre (LVC) fewer than 4 DP annually.
Results: A total of 194 DPs were performed at 18 different hospitals. Of these 42% (81) were performed in HVCs (2 hospitals), 43% (84) in MVCs (6 hospitals) and the remaining 15% (29) in LVCs (10 hospitals). Patient demographics did not differ between the hospital volume groups. The overall rate of clinically relevant POPF, Clavien-Dindo grade 3–5 complications, and 90-day mortality showed no significant differences between the different hospital volumes. Grade C POPF was found more often in LVCs, being 1.2% in HVCs, 0% in MCVs and 6.9% in LVCs, $p = 0.030$. More reoperations were performed in LVCs (10.3%) than in HVCs (1.2%) or MVCs (1.2%); $p = 0.025$.
Conclusions: Even though the rate of postoperative complications after DP is not affected by hospital volume, reoperations were performed ten times more often in the low-volume centres. Optimal management of postoperative complications may favour centralization not only of PD, but also of DP.

Introduction

Centralization of treatment of pancreatic surgery reduces postoperative mortality and morbidity and also improves long-term survival after pancreatoduodenectomy (PD) [1–4]. Compared to PD, postoperative pancreatic fistulas (POPF) are even more common – though less life-threatening - after distal pancreatectomy (DP) and overall morbidity also remains high [5–7]. The effect of hospital volume on complications after DP has not been widely studied [8]. The aim of this study was to analyze whether hospital volume affects the rate of POPF and overall morbidity after DP according to a nationwide database.

Methods

All patients undergoing DP in the period 2012–2014 were identified from the Finnish Operation and Treatment Register (HILMO) using Nordic Classification of Surgical Procedures codes (ICD10 codes JLC10 and JLC11). All patient records were collected and examined manually. Emergency operations and patients with no data available were excluded.

Postoperative complications, POPF, mortality, reoperations and

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hospital stay were registered. Data on the course of the surgery was also gathered. Complications were graded according to the Clavien-Dindo classification and grades 3–5 were considered major complications [9]. Postoperative pancreatic fistulas were graded according to the new ISGPF classification [10,11]. In grade B fistula the drain is left in place for over 3 weeks or repositioned through percutaneous or endoscopic procedures. Grade C fistula requires either reoperation or leads to organ failure or death of the patient. The final histopathological diagnoses were also gathered.

The hospital DP volumes were calculated and the hospitals were categorized according to operation volume. For this study, high-volume centres (HVC) were defined as those performing 10 or more distal pancreatectomies per year Median-volume centres (MVC) accomplished 4–9 DPs and low-volume centres (LVC) less than 4 DPs per year.

Ethical approval for the study was granted by the Regional Ethics Committee of Pirkanmaa, Finland (ETL code R12241).

Statistical analysis

Fisher's exact test and ×2 test were used as appropriate to calculate statistical differences. Statistical analysis was performed with IBS SPSS statistics software. $P \leq 0.05$ was considered statistically significant.

Results

One hundred and ninety-four DPs were performed in Finland between 2012 and 2014 in 18 different hospitals. There were two HVCs, 6 MVCs, and 10 LVCs. Of DPs 85% (165) were performed in HVCs and MVCs (41% in HCVs and 44% in MVCs) and 15% (29) in LVCs. In total 81 DP/3 yr were performed in HVCs, 84 in MVCs and 29 in LVCs.

Patient demographics or perioperative data did not differ between the centres (Table 1). Combined splenectomy (median 60%, range 51–69%) and resection of other organs (16%, range 11–20%) were performed without differences between the centres. Blood loss (median 700 ml, range 10–16000 ml) and operative time (median 187min, range 114–317min) were also similar regardless of hospital volume. For pancreatic stump closure stapler was used in 69% of patients, and the methods did not differ between the groups. There were more laparoscopic procedures in HVCs and MVCs than in LVCs (28%, 27% and 3% respectively, $p = 0.008$).

The proportion of malignant diseases was similar between the centres. The final histopathological diagnoses are shown in Table 2.

The overall rate for POPF (B/C) rate was 17.2% in all patients. POPF occurred in 21% in HVCs, 10.7% in MVCs and 17.2% in LVCs.

Table 2
Final histopathological diagnoses: all patients.

Adenocarcinoma	40 (21%)
Neuroendocrine carcinoma	7(3,6%)
Intraductal papillary mucinous carcinoma	2(1%)
Gastrointestinal stromal carcinoma	1 (0,5%)
Kidney metastasis	6 (3%)
Colon carcinoma	1 (0,5%)
Neuroendocrine tumour	43 (22,%)
Mucinous cystic nesplasm	23(11,9%)
Intraductal papillary mucinous neoplasm	17 (8,8%)
Serous cystic neoplasm	20 (10%)
Solid pseudopapillary neoplasm	3 (1,5%)
Chronic pancreatitis	7 (3,6%)
Pseudocyst	7 (3,6%)
Gastrointestinal stromal tumour	1 (0,5%)
Cyst	5 (2,6%)
Fibrosis	1 (0,5%)
Spleen accessorius	7(3,6%)
Hemangioma	1(0,5%)
Nesidioblastooma	1(0,5%)

Grade C POPF was found more often in LVCs, the rate being 1.2% in HVCs, 0% in MCVs and 6.9% in LVCs, $p = 0.030$. The rate of intra-abdominal collections was similar; they occurred respectively in 28%, 25%, and 20.7% in HVCs, MVCs and LVCs. Interventional drain or pancreatic stent was used similarly in the centres to drain a collection in the postoperative treatment of POPF. Delayed gastric emptying (DGE) was found to be more common in LVCs (20.7%) than in HVCs/MVCs (3.7%/10.7%; $p = 0.018$). However, no difference was found in other complications such as postoperative pancreatitis, lymphatic leak, post-pancreatic hemorrhage (PPH), wound infection, pneumonia or pulmonary embolism (Table 3).

Clavien-Dindo 3–5 complications occurred in 16.0% of HVC patients, in MVCs in 18.1% of patients, and in LVCs in 20.7% of patients. In LVCs the rate for major complications tended to be higher, but this was not statistically significant ($p = 0.81$). Ninety-day mortality was 0% in HVCs and in the LVC group and 2.4% in MVCs.

Significantly more reoperations were performed in LVCs, on 10.3% of patients (3/29), than in HVCs and MVCs: 1.2% (1/82) and 1.2% (1/87) respectively, $p = 0.025$. Due to the small number of reoperations, multivariate analysis was not possible. Out of the three re-operated patients in the LVCs, the first patient had POPF, PPH and pneumonia and was treated in the ICU. He underwent reoperation twice; on day 19 due to PPH and intra-abdominal collection (splenectomy and drain repositioned) and on day 49 due to 15 cm wide peripancreatic collection with amylase-rich fluid (drain repositioned). The second patient underwent reoperation on

Table 1
Pre- and perioperative characteristics across the groups.

	High-Volume centre n (DP) = 81	Medium-volume centre n(DP) = 84	Low-volume centre n (DP) = 29	Overall volume n (DP) = 194	
Age, median, years (range)	62 (0.3–80)	65 (21–80)	67 (41–85)	64 (0,3–85)	
Sex ratio (F/M)	45/36	60/24	17/12	122/72	
BMI	26,1 (16–40)	23,6 (19–40)	28,4 (23–36)	26,1 (16–40)	
Diabetes	20 (24,7%)	10 (14,1%)	8 (29,6%)	21,2% (38)	
Laparoscopic procedure	23 (28,4%)	23 (27,4%)	1(3,4%)	47 (24,2%)	p = 0.008
Combined resection of other organs	9 (11,1%)	17 (20,2%)	4 (13,8%)	30 (15,5%)	
Hand -sewn closure of the pancreatic	25 (30,9%)	20 (23,8%)	11 (37,9%)	56 (28,9%)	
Stapler closure of pancreatic stump	54 (66,7%)	64 (76,2%)	16 (55,2%)	134 (69,1%)	
Splenectomy	42 (51,9%)	58 (69,0%)	16 (55,2%)	116 (59,8%)	
Blood loss (ml)	850 (150–5300)	590 (0–16000)	500 (300–2500)	700 (0–16000)	
Oper. time (min)	167 (115–317)	200 (114–377)	180 (120–258)	187 (114–377)	
Number of hospitals	2	6	10	18	

Table 3
Postoperative complications in the groups.

% (n)	High-volume centre n = 81	Medium-volume centre n = 84	Low-volume centre n = 29	
Pancreatic Fistula				
Grade B	19,8% (16)	10,7% (9)	10,3% (3)	
Grade C	1,2% (1)	0,0% (0)	6,9% (2)	P = 0,030
Grade B/C	21,0% (17)	10.7% (9)	17,2% (5)	
PPH	4,9% (4)	4,8% (4)	6,9% (2)	
DGE	3,7% (3)	10,7% (9)	20,7% (6)	P = 0,018
Intra-abdominal collection	28,4% (23)	25,0% (21)	20,7% (6)	
Interventional drain	13,6% (11)	11,9% (10)	10,3% (3)	
Pancreatic stent	2,5% (2)	2,4% (2)	6,9% (2)	
CT verified pancreatitis	3,7% (3)	2,4% (2)	0,0% (0)	
Lympha leak	1,2% (1)	1,2%(1)	0,0% (0)	
Wound-infection	9,9% (8)	3,6% (3)	10,3% (3)	
Pneumonia	12,3% (10)	6,0% (5)	10,3% (3)	
Pulmonary embolism	3,7% (3)	0,0% (0)	5,0% (1)	
Clavien-Dindo III-V	16,0% (13)	18,1% (15)	20,7% (6)	
Reoperation	1,2% (1)	1,2% (1)	10,3% (3)	p = 0,025
Total hospital stay, median (range)	7 (3–25)	8 (3–30)	8 (5–40)	
Readmission	16,3% (13)	13,1% (11)	24,1% (7)	
90-day mortality	0,0% (0)	2,4% (2)	0,0% (0)	

day 8 due to infection and inadequate blood flow to the spleen seen in ultrasound (splenectomy, drain repositioned; produced amylase-rich fluid). The third patient underwent reoperation on day 10 due to DGE (nasogastric tube repositioned, inflammation detected around pancreas with jejunal loops attached). The indications for reoperations in the HVC group were bowel necrosis caused by atherosclerosis and prolonged infection due to POPF, and in the MVC group ureter injury sustained in the primary operation. Clavien-Dindo complication, reoperation and readdmission rates are seen in Fig. 1.

There were no differences in total hospital stay, readmission rate or 90-day mortality. These parameters are shown in Table 3. There were two deaths within 90 days postoperatively, both in the MVC group. The first patient died on day 3. This patient had a BMI of 40, and had breathing problems before his death, probably because of a pulmonary embolism. The second patient died on day 12 due to postoperative bleeding. Hemoglobin level was 23 g/l before her death. She also had cholangitis and a choledochal stone had been removed in endoscopic retrograde cholangiography (ERC) 2 days earlier.

In univariate analysis, no single factor significantly affecting the formation of clinically relevant POPF was found. In all open procedures the clinically relevant fistula rate was 17.2% and in the laparoscopic procedures 12.8% (ns). Combined resection of other organs raised the fistula rate up to 23.3% but without a significant difference between different centre volumes. In stapler closure and in hand sewn closure groups the respective fistula rates were 17% and 17.0% (ns). Malignancy did not protect against fistula formation, the POPF rate being 14,2% in all malignant cases.

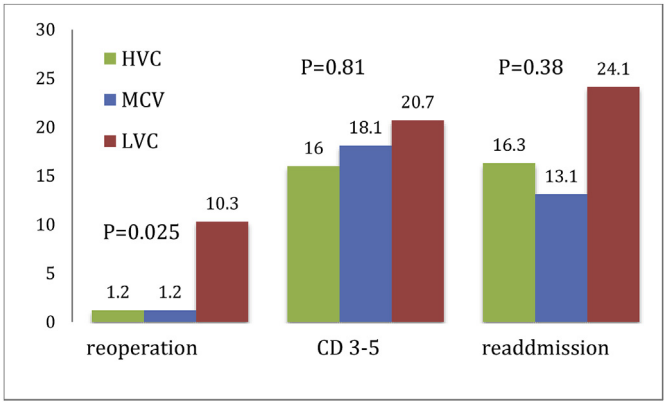

Fig. 1. Reoperation, Clavien-Dindo 3–5 grades and readdmission rates seen in different centres. HVC = high volume centre, MVC = median volume centre, LVC = low volume centre).

Discussion

Ample evidence supports the centralization of PDs [12–16], but it is not known whether it would be beneficial also to centralize DPs. Our aim was to study the effect of hospital volume on the outcome of all DP operations performed nationwide in Finland during the period 2012–2014. We found that the frequencies of clinically relevant POPF and Clavien-Dindo 3–5 complications were not related to hospital volume. However, the management of complications differed significantly, as more reoperations were performed in the LVCs.

The reoperation rate in LVC was 10.3% and included three patients. One might speculate that these were all unnecessary. The first patient with PPH, POPF and intra-abdominal collection, who twice underwent relaparotomy, could have been managed by interventional radiological procedures. The second patient who had an infection and inadequate blood flow to the spleen on ultrasound could have been managed without laparotomy if a CT scan had been performed. The third patient who underwent a laparotomy for DGE could have been managed by watchful waiting, medical treatment, and repeated imaging. Most of the postoperative complications, which in the past may have needed surgery, can today be treated with conservative or minimally invasive approaches. In the low-volume centres the options for modern treatment may be limited.

A laparoscopic approach was taken, most often in HVCs and MVCs. Overall, laparoscopy seems to be underutilized in DPs in Finland, as the overall rate is so low (24%). Laparoscopic DP is associated with significantly less overall morbidity than open technique. Blood loss is smaller and the length of hospital stay is shorter [17]. However, no significant difference in clinically relevant POPF was found. In the LVCs laparoscopic approach was rare which might be explained by the low volume affecting the learning process. Thus, centralizing the procedures to at least MVC/HVC level might be beneficial even in this respect.

The overall clinically relevant POPF rate in our study was 17.2%, which is comparable to what has been reported elsewhere. Postoperative complications occur even in HVCs, and also in this study

no significant difference was found either in the incidence of POPF or in Clavien-Dindo 3–5 complications. Nor has a decrease in overall complication rate or POPF rate after DP been reported in HVCs vs. LVCs in the literature. However, only few studies report the rates of complications after DP separately [8]. In our study, DGE seemed to be more common in LVCs, but the patient records may not have all the information reliably listed.

Several studies have reported an association between high hospital volume and lower postoperative mortality in pancreatic surgery [1,2]. It has been shown that higher mortality in low volume centres with high-risk surgery is associated with the hospital's ability to rescue patients from major complications [3,18] The mortality risk is also attributable to patient characteristics, such as age and comorbidity [19]. In this study the deaths occurred in the MVC group and were both sudden and not caused by a treated complication, but one of them was associated with comorbidity, i.e., obesity.

PD has been shown to carry lower mortality and morbidity and also better oncological outcome in high-volume centres [1,20]. So far, centralization of DPs in high-volume centres does not seem to occur, although only few studies have been presented concerning only DPs in terms of postoperative complications and hospital volume [8]. One article which claimed that pancreatic resections can be safely done in MVCs had only 13 DP/11 yrs with a clinically relevant POPF rate in DP of 32% [21]. Factors favoring centralizing DP as well as PD include the overall knowledge of pancreatic surgery and its complications and postoperative care. Treatment and care may require imaging and interventional radiology around-the-clock and the decision-making for treatment also needs a multidisciplinary approach, which is often lacking in LVC units. Reasonable volumes are needed to achieve and maintain experienced perioperative management. When analysing all patient records from each hospital manually we found no differences between HVCs and LVCs in terms of equipment used in surgery. Time of drain removal varies within centres according to individual surgeon. However, we did find that multidisciplinary teams were used in all tertiary but only in some secondary hospitals (HVCs and MCVs) and in neither of the LVC hospitals. In Finland, where the population is only 5.4 million and both DP and PC volumes are generally small, it would be wise to centralize the know-how in fewer centres in order to achieve the best results.

Risk factors for POPF have been widely studied. A laparoscopic approach has been shown to reduce the overall complications, but not POPF [22]. Many closure methods for pancreatic stump have been developed to reduce the complications, especially POPF. The pancreas can be closed by suturing or staplers, the stump can be covered with various patches or meshes or Tachosil [23]. Pancreatico-jejunal anastomosis and preoperative pancreatic stent have also been used [24,25]. Neither of these has reduced the POPF rate in RCTs. In a recent RCT a ligament Teres patch was shown to significantly decrease reoperation, readmission and reintervention rates without affecting the POPF rate [26]. On the pharmaceutical side, the use of octreotide is controversial. It has no effect on clinically relevant POPF, but it may reduce overall morbidity [27]. Pasireotide has been shown to reduce POPF rate to 7% after DP, in a recent RCT. High BMI has also been shown to increase the morbidity rate [28,29]. The effect of hospital volume in DP only has been poorly reported.

The strength of this study is the nationwide coverage of all DP operations performed in a single country during the study period. The study provides valuable information on nationwide DP volumes and complications rates. This is the first nationwide study on DP in Europe.

The weaknesses of this study include the missing and incomplete data. Patient data was collected retrospectively from 18 different hospitals in Finland and analyzed manually. POPF classification was made according the data found by the authors, so the analysis is consistent throughout the study [11]. Octreotide was not used routinely in any of the hospitals studied, although some surgeons did use it occasionally. It is therefore no included in the analysis. We could find no accurate information on drain removal time and were therefore unable to include this in the data. . Overall, the information is missing randomly and should not affect the results. The hospital volume definition is somewhat arbitrary, as in the literature definitions of volume mostly include both DP and PD. The number of patients in this study is also rather low since DP was performed quite rarely, which is also weakness of the study.

In conclusion, this nationwide register study shows similar POPF and overall complication rates after DPs performed in different volume hospitals in Finland during the period 2012–1014. However, there was a significant difference in the management of postoperative complications, as the reoperation rate was significantly more common in the LVCs. With experienced postoperative management, reoperations could possibly be avoided. This may favour the centralization of pancreatic resections to HVCs – not only for PD, but also for DP.

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